

FORM PTO-1390 (Modified)
(REV 11-2000)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

MACKLIN-03211

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

10/069011

INTERNATIONAL APPLICATION NO
PCT/GB00/03211INTERNATIONAL FILING DATE
18 August 2000PRIORITY DATE CLAIMED
21 August 1999

TITLE OF INVENTION

ANODE FOR RECHARGEABLE LITHIUM CELL

APPLICANT(S) FOR DO/EO/US

MACKLIN, William, James; FRAY, Derek, John

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (24) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
 - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☐ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☐ Certificate of Mailing by Express Mail
23. ☐ Other items or information:

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR <div style="font-size: 1.5em; font-weight: bold;">10/069011</div>		INTERNATIONAL APPLICATION NO. <div style="font-weight: bold;">PCT/GB00/03211</div>		ATTORNEY'S DOCKET NUMBER <div style="font-weight: bold;">MACKLIN-03211</div>	
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24. The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) : <div style="margin-left: 20px;"> <input type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1040.00 <input checked="" type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$890.00 <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$740.00 <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$710.00 <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00 </div> <div style="text-align: right; margin-top: 10px;"> ENTER APPROPRIATE BASIC FEE AMOUNT = <div style="float: right; width: 150px;">\$890.00</div> </div>				CALCULATIONS PTO USE ONLY	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input checked="" type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).				<div style="float: right; width: 150px;">\$130.00</div>	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	6 - 20 =	0	x \$18.00	\$0.00	
Independent claims	1 - 3 =	0	x \$84.00	\$0.00	
Multiple Dependent Claims (check if applicable). <input type="checkbox"/>				\$0.00	
TOTAL OF ABOVE CALCULATIONS =				\$1,020.00	
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.				\$0.00	
SUBTOTAL =				\$1,020.00	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).				\$0.00	
TOTAL NATIONAL FEE =				\$1,020.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable). <input type="checkbox"/>				\$0.00	
TOTAL FEES ENCLOSED =				\$1,020.00	
				Amount to be: refunded	\$
				charged	\$

a. ☒ A check in the amount of \$1,020.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 082670. A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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SIGNATURE
 William H. Holt
 NAME
 20766
 REGISTRATION NUMBER
 02/20/2002
 DATE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of *
*
MACKLIN, William, James et al *
*
New U.S. National Stage Application *
of International Application No. * Attention: DO/EO/US
PCT/GB00/03211 *
*
International Filing Date: *
18 August 2000 *

For: ANODE FOR RECHARGEABLE LITHIUM CELL

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Please amend as follows:

In the Claims:

Amend Claims 1 and 4 as follows:

1. (Amended) An anode for a rechargeable lithium cell, the anode comprising carbon nanotubes, characterized in that the nanotubes contain within them a metal or a metalloid selected from the group consisting of aluminium, tin, metallic alloys containing aluminium or tin, and silicon, that can form alloys reversibly with lithium over a range of compositions.

4. (Amended) A rechargeable lithium cell incorporating an anode as claimed in claim 1, a reversible cathode, and an electrolyte.

Add the following new claims:

5. (New) A rechargeable lithium cell incorporating an anode as claimed in claim 2, a reversible cathode, and an electrolyte.

6. (New) A rechargeable lithium cell incorporating an anode as claimed in claim 3, a reversible cathode, and an electrolyte.

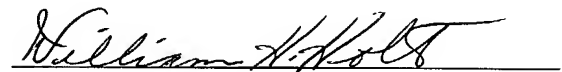
REMARKS

By this Preliminary Amendment, all multiple dependencies in the claims have been deleted, and some minor amendments as to form have been made. New Claims 5 and 6 have been added.

A marked up copy showing all the changes made to Claims 1 and 4 relative to the previous versions of those claims is submitted as ATTACHMENT A.

Favorable action is courteously solicited.

Respectfully submitted,



William H. Holt
Reg. No. 20766

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February 20, 2002

ATTACHMENT A

1. (Amended) An anode for a rechargeable lithium cell, the anode comprising carbon nanotubes, characterized in that the nanotubes contain within them a metal or a metalloid selected from[:] the group consisting of aluminium, tin, metallic alloys containing aluminium or tin, [or] and silicon, that can form alloys reversibly with lithium over a range of compositions.

4. (Amended) A rechargeable lithium cell incorporating an anode as claimed in [any one of the preceding claims] claim 1, a reversible cathode, and an electrolyte.

Anode for Rechargeable Lithium Cell

This invention relates to an anode for a rechargeable lithium cell, and to a cell incorporating
5 such an anode.

For many years it has been known to make cells with lithium metal anodes, and cathodes of a material into which lithium ions can be intercalated or inserted. A
10 wide variety of intercalation or insertion materials are known as cathode materials for rechargeable lithium cells, such as TiS_2 , V_6O_{13} and Li_xCoO_2 where x is less than 1; and these materials are often mixed with solid electrolyte material to form a composite cathode. To
15 avoid the problems arising from dendrite growth at lithium metal anodes during cycling, it has been proposed to use an intercalation material such as graphite as the anode material, and this also may be mixed with solid electrolyte material to form a composite anode.
20 Rechargeable cells of this type, in which both the anode and cathode contain intercalated lithium ions, are now available commercially, and may be referred to as lithium ion cells, or as swing or rocking-chair cells.

25 Another known possibility is to use, as the anode material, a metal such as aluminium that forms an alloy with lithium. However, repeated cycling of a cell with a lithium/aluminium alloy anode leads to volumetric changes and structural damage. Tin oxide has also been suggested
30 as a reversible anode material in a lithium ion cell. The lithium insertion process is believed to proceed by the initial reduction of the tin oxide, followed by reversible formation of the lithium alloy. While the

15

2 continued

reversible cathode, and an electrolyte. The electrolyte may be either a solid polymeric electrolyte, or a liquid electrolyte. Where the electrolyte is a liquid, an inert, liquid-permeable separator is usually provided to

- 3 -

separate the anode from the cathode. A variety of different intercalation materials may be used in such a cathode.

- 5 Such a cell can be expected to have improved capacity and improved reversibility, because the nanotubes will provide a stabilising framework for the alloy. The carbon nanotubes may also provide additional lithium intercalation capacity.
- 10
- Carbon nanotubes are tube-like structures of diameter no more than a few nanometres, but which may be several micrometres in length. They can be considered as a sheet or hexagonal lattice of carbon atoms (as in a
- 15 layer of graphite) which has been rolled up to make a cylinder, with a hemispherical cap like half a fullerene molecule at each end. The nanotubes can be characterized by their diameter, and their helicity, which is determined by the axis about which the sheet is rolled.
- 20 They have been made by laser vaporisation of a carbon target in a furnace, in the presence of a cobalt/nickel catalyst; they have also been made using a carbon arc.

- The invention will now be further and more
- 25 particularly described, by way of example only. Carbon nanotubes are prepared electrolytically, by using a carbon electrode as cathode in a bath of molten salt, such as sodium chloride. It is believed that, on the application of current, sodium is forced into the
- 30 graphite structure and this induces the extrusion of the nanotubes. A less stable salt, such as tin chloride, is also introduced into the molten salt bath. This decomposes first, and the resulting metal (tin) is

initially deposited onto the surface of the graphite. It is found that the nanotubes resulting from this procedure contain the metal of the less stable salt inside the nanotubes. After electrolysis, the salt is dissolved in water; the nanotubes remain in suspension, but will collect at the interface between the aqueous solution and an immiscible organic liquid. In this way the nanotubes can be produced with high yield.

The tin-filled nanotubes made as described above are thoroughly dried. The nanotubes are then used to make an anode, by mixing 90 parts by weight of the nanotubes with 10 parts of polyvinylidene fluoride homopolymer (PVdF), forming a slurry with N-methyl pyrrolidone (NMP) as solvent for the PVdF, casting onto a copper foil current collector, and thoroughly drying the cast layer to remove the NMP solvent. A similar procedure is then used to make a cathode, mixing lithium cobalt oxide, carbon and PVdF with NMP as solvent to form a slurry, casting onto an aluminium foil current collector, and thoroughly drying the cast layer to remove the NMP solvent. The anode and the cathode are then separated by a microporous polyethylene separator, wound up to form a coil, and inserted into a can. The can is then filled with organic liquid electrolyte consisting of 1M LiPF_6 dissolved in ethylene carbonate/ethyl methyl carbonate mixture, and sealed.

It will be appreciated that an anode comprising only nanotubes and a polymer binder (such as polyvinylidene fluoride) is suitable where the anode is to be used in a cell with a liquid electrolyte. An alternative anode incorporates plasticising solvent (such as ethylene

15 Thus an alternative cell may be made as follows,
using aluminium-filled nanotubes that have been
thoroughly dried. Forty eight parts of the nanotubes are
mixed with 24 parts of the volatile solvent tetra-
hydrofuran to produce a slurry (all parts are parts by
20 weight). This is then mixed with a polymer solution
containing six parts of a PVdF copolymer, 30 parts of
salt solution (1 M LiPF_6 in a mixture of three parts
ethylene carbonate to two parts propylene carbonate), and
40 parts tetrahydrofuran. This mixture is then cast,
25 using a doctor blade over a roller with a blade gap 0.5
mm, onto a copper foil, and passed through a dryer at
70°C to ensure evaporation of the volatile solvent
tetrahydrofuran. In this particular example the
copolymer is of vinylidene fluoride with 2 percent by
30 weight of hexafluoropropylene, and has a sufficiently
high molecular weight that its melt flow index (at a
temperature of 230°C and a load of 21.6 kg) is only 3.1
g/10 min.

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The resulting anode comprises the aluminium-filled nanotubes along with copolymer, plasticising solvents and lithium salt. It can be combined with a composite
 5 cathode and a polymer electrolyte to form a reversible lithium ion cell.

- 7 -

Claims

1. An anode for a rechargeable lithium cell, the anode comprising carbon nanotubes, characterized in that the
5 nanotubes contain within them a metal or a metalloid selected from: aluminium, tin, metallic alloys containing aluminium or tin, or silicon, that can form alloys reversibly with lithium over a range of compositions.
- 10 2. An anode as claimed in claim 1 wherein the carbon nanotubes are bound together by a polymeric binder.
3. An anode as claimed in claim 2 comprising both a polymeric binder and a plasticising solvent.
- 15 4. A rechargeable lithium cell incorporating an anode as claimed in any one of the preceding claims, a reversible cathode, and an electrolyte.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
1 March 2001 (01.03.2001)

PCT

(10) International Publication Number
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C01B 31/02

(21) International Application Number: PCT/GB00/03211

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(30) Priority Data:
9919807.9 21 August 1999 (21.08.1999) GB

(71) Applicant (for all designated States except US): **AEA TECHNOLOGY PLC** [GB/GB]; 329 Harwell, Didcot, Oxfordshire OX11 0QJ (GB).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **MACKLIN, William, James** [GB/GB]; Southernwood Cottage, Cat Street, East Hendred, Oxfordshire OX12 8JT (GB). **FRAY, Derek, John** [GB/GB]; 7 Woodlands Road, Great Shelford, Cambridge, Cambridgeshire CB2 5LW (GB).

(74) Agents: **MANSFIELD, Peter, Turquand et al.**; AEA Technology plc, Patents Dept., 329 Harwell, Didcot, Oxfordshire OX11 0QJ (GB).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

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Published:

- With international search report
- Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ANODE FOR RECHARGEABLE LITHIUM CELL

(57) Abstract: An anode for a rechargeable lithium cell comprises carbon nanotubes that contain within them an element that can form alloys or compounds reversibly with lithium over a range of compositions. The element within the nanotubes may be aluminium or tin. These carbon nanotubes are bound together to form a coherent layer with a polymeric binder, such as a polymer of vinylidene fluoride. A cell with such an anode should have improved capacity and improved reversibility, because the nanotubes provide a stabilising framework for the alloy.

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As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **Anode for rechargeable lithium cell**

the specification of which is attached hereto, unless the following box is checked

☒ was filed on 18th August 2000 as United States Application Number or PCT International Application

Number PCT/GB00/03211 and was amended on 18th June 2001 (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56

I hereby claim foreign priority benefits under Title 35, United States Code, § 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International Application which designated at least one country other than the United States of America, listed below and have also identified below any foreign application for patent or inventor's certificate, or of any PCT International application having a filing date before that of the application on which priority is claimed

99 19807.9
(Number)

United Kingdom
(Country)

21st August 1999
(Day/Month/Year Filed)

Priority Claimed

☒ Yes ☐ No

Priority Claimed

☐ Yes ☐ No

(Number)

(Country)

(Day/Month/Year Filed)

☐ Additional applications identified on attached sheet

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s), or 365(c) of any PCT International application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

(Application Serial Number)

(Filing Date)

(Status) (patented, pending, abandoned)

(Application Serial Number)

(Filing Date)

(Status) (patented, pending, abandoned)

☐ Additional applications identified on attached sheet

I hereby appoint the following attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith

William H. Holt, Reg No 20766; D Peter Hochberg, Reg No 24603, Ronald E. Greigg, Reg No 31517; Howard M. Ellis, Reg No. 25856, David J. Serbin, Reg No 30589

Direct all telephone calls to **WILLIAM H. HOLT**, Telephone Number (703) 838-2700

Address all correspondence to **LAW OFFICES OF WILLIAM H. HOLT, 1423 Powhatan Street, Unit 2, First Floor, Alexandria, Virginia 22314.**

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon **22 February 2002**

Full name of Sole or First Inventor William John MACKLIN	Inventor's Signature <i>W. J. Macklin</i>	Date 22/02/02
Residence EAST HENDRED, OXFORDSHIRE, UNITED KINGDOM		Citizenship BRITISH GBN
Post Office Address c/o ACCENTUS PLC, PATENTS DEPT., 329 HARWELL DIDCOT, OXFORDSHIRE, OX11 0QJ, UNITED KINGDOM		
Full name of Second Joint Inventor	Inventor's Signature	Date
Residence		Citizenship
Post Office Address		
Full name of Third Joint Inventor	Inventor's Signature	Date
Residence		Citizenship
Post Office Address		

☐ See attached sheet for similar information and signatures for additional joint inventors.

LAW OFFICES OF WILLIAM H. HOLT, 1423 Powhatan Street, Unit 2, First Floor, Alexandria, Virginia 22314

As a below named inventor, I hereby declare that

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **Anode for rechargeable lithium cell**

the specification of which is attached hereto, unless the following box is checked:

☒ was filed on 18th August 2000 as United States Application Number or PCT International Application

Number PCT/GB00/03211 and was amended on 18th June 2001 (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1 56

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International Application which designated at least one country other than the United States of America, listed below and have also identified below any foreign application for patent or inventor's certificate, or of any PCT International application having a filing date before that of the application on which priority is claimed

99 19807.9
(Number)

United Kingdom
(Country)

21st August 1999
(Day/Month/Year Filed)

Priority Claimed

☒ Yes ☐ No

Priority Claimed

☐ Yes ☐ No

(Number)

(Country)

(Day/Month/Year Filed)

☐ Additional applications identified on attached sheet

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s), or 365(c) of any PCT International application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1 56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial Number)

(Filing Date)

(Status) (patented, pending, abandoned)

(Application Serial Number)

(Filing Date)

(Status) (patented, pending, abandoned)

☐ Additional applications identified on attached sheet

I hereby appoint the following attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith

William H. Holt, Reg No 20766; D. Peter Hochberg, Reg No 24603; Ronald E. Greigg, Reg No 31517; Howard M. Ellis, Reg No 25856; David J. Serbin, Reg No 30589

Direct all telephone calls to **WILLIAM H. HOLT**, Telephone Number: (703) 838-2700

Address all correspondence to **LAW OFFICES OF WILLIAM H. HOLT, 1423 Powhatan Street, Unit 2, First Floor, Alexandria, Virginia 22314.**

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon

Full name of Second Joint Inventor Derek John FRAY	Inventor's Signature <i>Derek John Fray</i>	Date 5th February 2002
Residence GREAT SHELFORD, CAMBRIDGESHIRE, UNITED KINGDOM		Citizenship BRITISH GBN
Post Office Address c/o ACCENTUS PLC, PATENTS DEPT., 329 HARWELL DIDCOT, OXFORDSHIRE, OX11 0QJ, UNITED KINGDOM		
Full name of Third Joint Inventor	Inventor's Signature	Date
Residence		Citizenship
Post Office Address		
Full name of Fourth Joint Inventor	Inventor's Signature	Date
Residence		Citizenship
Post Office Address		

☐ See attached sheet for similar information and signatures for additional joint inventors.

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